ARTILLERY VOLUNTEER
OFFICERS CATECHISM
BY
LT. COL. J. M. MACINTYRE

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CATECHISM

FOR

OFFICERS OF ARTILLERY VOLUNTEERS.

BY

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ROYAL (LATE MADRAS) ARTILLERY.

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PREFACE.

When examining officers of Artillery Volunteers* for certificates of proficiency, the Author of this Catechism observed that a difficulty in qualifying lay in the number and variety of the necessary sources of information.

He therefore offers this compilation as an assistance in preparation for the examinations, and as a simplification of the undertaking.

The authorities who have been consulted are—Colonel Vesey, R.A.; Colonel Biddulph, D.A.G., India; Captain Majendie; Captain C. Orde Browne, R.A., &c., &c.

Agra, 1872.

* The technical changes in this arm of the Service have latterly been so frequent, that some few of the answers in the following catechism may have ceased to be precisely accurate by the time *of its issue from the press.*

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CATECHISM

FOR

'ICERS OF ARTILLERY VOLUNTEERS.

ARTILLERY.

Into how many classes may ordnance be divided? to four, viz., shot guns, shell guns, mortars, and tzers.

What materials are used in the construction of ord-e ?—Bronze, cast iron, wrought iron, and steel.

What are the component parts of the bronze used in ervice ?—Copper, 90·5 ; tin, 9·5.

What bronze guns are used in the service, and what tzers and mortars ?—

ıe 12-pr. gun	32-pr. howitzer	$5\frac{1}{2}$-in. mortar
9-pr. „	24-pr. „	$4\frac{2}{5}$-in. „
6-pr. „	12-pr. „	
3-pr. „	$4\frac{2}{5}$-pr. „	

What are the cast-iron guns and mortars in use ?—

he 68-pr. gun	10-in. howitzer	13-in. sea mortar
42-pr. „	8-in. „	13-in. land „
32-pr. „		10-in. sea „
24-pr. „		10-in. land „
18-pr. „		8-in. „ „
10-in. shell gun.	Some few carronades still exist,	
8-in „ „	but are fast disappearing.	

What are the wrought-iron guns in the service ?—e may be divided into two classes, viz. breech-loading *nuzzle-loading*. There are two descriptions of breech-*g guns*, viz. those closed by a screw and those clos *wedge system*. Those closed by a screw are—

The 7-in. gun
40-pr. „
20-pr. „
12-pr. „
9-pr. „
6-pr. „

The wedge breech-loaders are—

The 64-pr. gun
40-pr. „

The muzzle-loaders are—

The 13-in. gun (only two or three have been made.)
12-in. „
10-in. „
9-in. „
8-in. „
7-in. „
64-pr. „
16-pr. „
9-pr. „

In addition to these a new 12-in. gun, weighing 35 tons has been made. (11·6in.)

7. What guns have been made entirely of steel?—Two were made experimentally for mountain train service That adopted into the service is commonly called a 7-pounder, and is generally known as the Abyssinian Gun Its calibre is three inches.

8. What is the object of rifling guns, and how is this object obtained?—To insure greater accuracy of fire than can be obtained by smooth bore. A rotatory motion is given to the shot round an axis parallel to that of the gun and the charge is so regulated that sufficient power is given to counteract the pressure of the air which would otherwise deflect the projectile from its true course, and render its flight irregular.

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9. State the principal systems of rifling which ha been tried.

(1) Muzzle and breech-loading guns having proj tiles which fit the bore mechanically, such as the Wh worth and Lancaster guns.

(2) Muzzle-loaders with projectiles having soft-me studs, such as the Armstrong shunt, French and Wo wich systems.

(3) Muzzle-loading guns having projectiles with soft metal coating, which is expanded by the gas in t bore, such as Britten's system.

(4) Breech-loading guns having a soft metal coati larger than the bore, which on firing is compressed in the grooves of the bore, such as the Armstrong a Prussian systems.

10. How are the breech-loading guns of the serv rifled?—In the bore there are a number of small groov The lower end of the bore is enlarged to form a sh chamber, and in the rear of all is the powder chamb which is not rifled.

11. What description of shot or shell is used with the guns?—An iron leaden-coated projectile larger in diame than the bore of the gun, into the grooves of which it forced on the explosion of the charge, and thereby obta its rotatory motion.

12. Describe how a screw breech-loader is closed at t breech.—It has a vent piece, on the face of which is copper ring shaped at an angle to correspond with anoth copper ring at the end of the powder chamber. Th being screwed up from behind is supposed to prevent escape of gas. The vent piece of the 7-inch gun is not *with copper*, but a tin cup* is placed behind the car *to effect* the same object.

* Tin cups are now supplied for all natures

13. What description of projectile is used with the service muzzle-loading guns?—The projectiles used with these guns have soft metal studs which fit the grooves.

14. What are the advantages and disadvantages of breech-loading guns?—The great advantage claimed by Armstrong for his system was that windage was done away with. Breech-loading guns have in addition the following advantages:—They can be worked in smaller space. The gunners are less exposed whilst loading. The bore can be seen into and cleaned, and in firing more easily cleared of any ignited substances that are in the bore. There is no danger of the shot not being home, thus leaving an air space between shot and cartridge, which might cause the gun to burst. The disadvantages are:—Complication of construction, weakness and want of endurance compared with the muzzle-loader, the unwieldiness of the breech-loading apparatus in heavy guns, and the fact that a trained set of artificers are necessary to be kept up with all breech-loading batteries to keep the guns serviceable, which would be most difficult to do on field service, especially in our distant colonies and dependencies.

15. What are the advantages and disadvantages of muzzle-loading guns?—The principal advantages are strength and simplicity of construction. They will bear very rough usage on service, and require no skilled artificers to keep them in order. The projectile having only soft studs instead of a leaden coating there is no liability to strip, which occasionally occurs with the breech-loader, whereby damage might be done to one's own troops. On the other hand, the gunners are more exposed in loading, and the danger of the shot not being rammed home is a great disadvantage.

16. Can you state the advantages claimed for breech-loaders as field artillery guns?

(1) Superior accuracy and rapidity of fire.

(2) Freedom from danger in loading, especially on field days and when used for saluting

(3) Facility for being rendered useless to an enemy by carrying off vent-piece.

(4) Facility for removing the vent which in any gun is the part which deteriorates by use.

(5) Convenience for removing any obstruction from the bore, and of ascertaining its interior condition by being able to look through from end to end.

(6) Convenience of being able to move the guns ready loaded, should special circumstances render it desirable to do so.

(7) Convenience for firing at angles of considerable depression.

17. What is asserted on the other hand by the opponents of breech-loading? First, as to the gun and its service—

(1) The breech-closing apparatus is liable to become unserviceable in various ways, such as—by the fracture of the vent piece; by the breech screw becoming jammed, which may be caused by grit, by an accidental blow on the screw-thread, or by rust, or by the copper facings at the junction of the vent piece and powder chamber losing the evenness of surface necessary for preventing the escape of gas.

(2) In the excitement of action, or by careless service, the gun may be fired when the breech screw is not fully screwed up, in which case the vent piece may be blown out, and at any rate the result of the shot spoiled.

(3) The number of separate parts and the delicacy of adjustment they require for effective use entail the employment of skilled artificers and an unremitting care on the part of the gunners, which it might be almost impossible to give on field service.

(4) Some of the parts essential to the working of gun, such as the lever handle of the screw and

breech screw itself, when the vent piece is withdrawn for loading, project in a manner which renders the gun in some degree more likely to be hit and disabled in action.

Secondly, as to the ammunition.

(5) The detonating composition, which is necessary to fire the time-fuzes is liable to deteriorate, and the fuzes, if not spoilt, are rendered uncertain in their action.

(6) The mode of action of the time fuzes is so difficult to understand and to apply, that many of the gunners are unable thoroughly to acquire it.

(7) The lead coating of the projectiles is liable to strip when the gun is fired, if the original fixing is not in perfectly good order, or if there is no lubrication used; and if any saline liquid finds its way between the lead and iron a deleterious action is excited. This has been obviated by zinc solder attachment.

(8) The lead coating is easily injured by travelling, if loosely packed, or by being accidentally struck or dropped. If it loses its form by bulging at the base, or by getting deeply scratched, it will not enter the gun until its irregularities of form and surface are removed.

(9) If the lubricators should happen to be wanting, the gun would soon become incapable of firing.

(10) These lubricators form a most expensive part of breech-loading ammunition, and are also dangerous to troops over whose heads it may be necessary to fire.

(11) The Store Department of an army in the field would be complicated and hampered to a most serious degree by the provision of all the separate articles essential to the gun, and by keeping up the necessary *reserves of them.*

17. These being the alleged advantages and disadvan*tages of the breech-*loader compared with the muzzle-*loading gun, on what* grounds do you suppose that

muzzle-loader has been adopted as the field-gun of the service?

(1) The superior accuracy of the breech-loader has not made itself apparent in the special trials instituted for the express purpose of testing it, and the extra rapidity is only applicable to cases of the very rarest occurrence; the muzzle-loaders are equally capable of any rate consistent with careful practice and ordinary circumstances.

(2) The danger in loading for firing at drill and salutes is undoubtedly reduced to a very minimum by breech-loading, but it is not altogether removed, one, if not more, fatal accidents having occurred, but with careful sponging and the vent well served, there is very little chance of accident with the muzzle-loader. When projectiles are used, there is no possibility of injury to the gun from the shot not being rammed home close up to the charge, but a very slight injury to the projectile itself will prevent its being loaded at all.

(3) There are occasions in which guns may be deliberately left exposed to the chance of capture, in order that their fire may be kept up to the last moment, as, for instance, at the Battle of Waterloo, where the guns were frequently left outside the infantry squares, after being steadily served up to the latest possible moment, the gunners taking temporary refuge inside the infantry squares from the French cavalry. As soon as the cavalry withdrew the fire was resumed. But it is doubtful whether the power of removing the vent-piece can be conceded to be a useful property. In the hurry of action men are not likely to carry out the drill instructions for rendering a gun unserviceable. It may likewise *be added*, that the means of detaching the vent-piec *makes* them liable to be lost or removed by treacher

(4) As a set-off against the facility of replacing a *out* vent, by changing the vent-pieces, there is the

sity of occasionally refacing the copper rings on the vent-piece and powder chamber, and of replacing them after a time with new ones. Before the Ordnance Select Committee it was proved that a breech-loader with these vent-pieces would require the copper rings to be renewed as often as the muzzle-loader would require to be revented, and it would, in addition, need refacing three times. The vent itself would at some time also have to be renewed.

(5, 6, and 7) Are advantages that may be conceded as convenient on special occasions, which, however, are very unlikely to occur, and even then arrangements could be made for arriving at the same objects with muzzle-loaders, although perhaps not quite so easily or quickly. The disadvantages cited almost explain themselves, and rest on undoubted authority. In 1864 alone forty-five vent-pieces were split. In China the breech-screws were on one occasion nearly completely jammed with rust, and on another occasion, at Aldershot, a gun was disabled during a whole field-day by getting some grit into the screw. In fact, we gain nothing by the breech-loading system in range, accuracy, or quickness of fire, to compensate for having a gun, with delicate and complicated machinery, requiring skilled artificers to keep it in order, and a great variety of stores for its sole use.

N.B.—The above comparison is taken principally from an admirable paper by Lieut.-Colonel F. Miller, R.A., V.C., in the Proceedings of the R.A. Institution.

AMMUNITION FOR SMOOTH-BORED ORDNANCE.

To what is the term ammunition applied?—To the ·ges of powder, to the projectiles, and the different liances used for igniting the charges of ordnance or ll arms, and the fuzes.

What projectiles are fired from smooth-bored ord- ce?—Round shot, grape and canister (or case shot), mon shells, diaphragm, and shrapnel, light balls, car- es.

What is grape shot, and how is it made?—The ori- ıl grape shot, some of which is still in the service, ıgh superseded by Caffin's pattern, consisted of an iron e, from the centre of which passed up an iron spindle, ıd which were piled sand shot, inclosed in a canvas , the bag being drawn together between the balls, or ted by a strong line. From its rough likeness to a ch of grapes it obtained its name.

ll grape, with the exception of that for carronades and 10-inch gun, is now made of Caffin's pattern, and consists 'our horizontal plates, the lower one wrought and the ɜrs cast iron, through the centre of which passes a ught iron spindle bolt, headed at the lower end, and hav- a screw to receive a nut at its upper end. Between plates are arranged three tiers of sand shot, three in each , except for the 56-pounder which has four shot, and 68-pounder which has five. The bottom plate has ɜntations corresponding to the number of shot in the er tier, in which indentations these shot rest. The ɜr plates have holes cast in them for the shot to rest in, , as these holes receive the upper parts of the shot of tier and the lower parts of the shot of the tier n e, each plate is furnished with double the numb that there are shot in a tier. The whole are

together by screwing the nut on to the spindle tightly down upon the upper plate. Grape for carronades resembles the case for the corresponding natures of ordnance, being a tin cylinder, with iron *bottom*, filled with balls. The balls, however, are larger and fewer, and the cylinder longer.

The 10-inch grape is an *iron* cylinder filled with 3-pound balls, and having an iron *top* and *bottom*, the top being furnished with an iron handle.

4. What is canister shot?—Canister or case shot (old pattern) had a tin case, the bottom plate iron, with a rope handle. For the 32-pounder and 8-inch gun, and Howitzer 68-pounder gun, 10-inch gun, and Howitzer, the new pattern is used, and consists of a hollow iron cylinder with iron ends. Both are filled with sand shot of different sizes, according to their natures, the interstices being filled with paper, shavings, sawdust, &c. The bottoms of the 10-inch and 8-inch are slightly rounded, to permit of the cartridge being sent home in simultaneous loading. The new pattern case shot is fitted with an iron handle at the top end. Case shot for bronze ordnance have wooden bottoms, on account of the iron being liable to score and injure the bore of bronze guns. The wooden bottom is shaped conical for Gomer-shaped chambered ordnance, and for unchambered ordnance of similar calibre, hemispherical for cylindrical-chambered, and cylindrical for all other ordnance.

5. What are common shells?—They are hollow spheres of cast iron, having a fuze hole for the reception of the fuze, by means of which the bursting charge with which the shell is filled is exploded at the proper time. The *12-pounder common shell* differs from the rest in having *its fuze hole fitted* with a gun metal bush or socket *extending some way into* the interior of the shell to make *the bursting of* the shell more certain, it having b

ound in practice that on the explosion of the bursting harge the common fuze was blown out, and the whole of he gas frequently escaped at the fuze hole without bursting he shell. All common shell are fitted with wooden ottoms to ensure the fuze occupying its proper place in he bore, viz., as nearly as possible in the axis of the piece nd on the side away from the charge.

6. What is improved shrapnel shell?—It is a thin cast ron spherical shell, made with a slight lip under the fuze ole. It contains a number of bullets varying in nature nd number according to the size of the shell. The ursting charge is contained in a tin cylinder attached to gun metal socket, which is screwed into the fuze hole, his cylinder passing down the centre of the shell. To revent the bullets from conglomerating or losing their hape they are hardened by about 15 per cent. of antimony eing added to the lead, and, with the same object, rosin s poured in between them to fill up the interstices. The osin also serves the purpose of effectually imbedding the alls, thus preventing them from pressing upon or breaking the tin cylinder which contains the bursting charge, nd being a brittle substance when cold is broken up on he bursting of the shell, and the bullets are at once liberated. The bullets are introduced into the shell through filling hole situated at the upper part of the shell near he fuze hole; this is closed and secured by a gun metal lug.

7. What is diaphragm shrapnel shell?—It is an invention of Colonel Boxer, R.A., who thus describes his invention:—"The peculiar features of the diaphragm shrapnel shell consist in the separation of the interior of the shell into two parts by a wrought iron partition or diaphragm, and n the metal of the shell being so disposed as to cause t ursting powder to open the shell in a manner to rel e bullets without causing irregular dispersion from

trajectory of the projectile." It is a thin cast iron shell divided into two unequal parts by a thin cup-shaped wrought iron partition or diaphragm. This diaphragm is supported by four small projections or flanges on its circumference, equidistant from each other, which are cast into the metal of the shell. It is situated with its convex side presented to the fuze hole, and of the two chambers thus formed in the interior of the shell the upper and smaller one, or powder chamber, contains the bursting charge, while the bullets are situated in the lower and larger division, which may, therefore, be called the bullet chamber. The shell is weakened in the interior by four grooves equidistant from each other, which taper in width and depth as they approach the top and bottom of the shell. These grooves form so many lines of least resistance along which the bursting charge takes effect, and so preserving the balls from the direct action of the bursting charge and opening the shell into several large pieces. They are riveted to wooden bottoms in the same way and for the same reasons as common shells.

8. What are light balls?—These are of two sorts, ground and parachute. Ground light balls are oblong projectiles about one and a half calibres in length. They consist of an iron skeleton frame, partially covered with canvas, filled with an inflammable composition, and woolded over what may be distinguished as the cylindrical part with cord or twine, vents being provided at the upper end for the composition to burn out of. They are fired from mortars, their object being to light up the enemy's works, and discover his working parties or position by night. Ground light balls very imperfectly answer the end required of them, for from their construction they can only be fired with small charges and to inconsiderable distances, an they are very uncertain in their flight. The parach light ball is an imperfect attempt to remedy the princ

lefects of the ground light ball. It consists of two hemispheres of tinned iron, soldered and riveted together so as ;o form a spherical shell to contain the parachute and ight. By means of a fuze and small bursting charge, when the shell is fired from a mortar, and sufficient force obtained to separate the outer hemispheres and relieve the parachute, to which is attached the light composition, which is ignited at the same moment, throwing a brilliant ight down on the enemy's works and working parties.

9. What are carcasses?—Carcasses are cast-iron shells illed with combustible composition, and having three fireioles or vents for the composition to burn out of, situated n the upper hemisphere equidistant from each other. The metal is considerably thicker than that of a common shell of corresponding calibre, being rather more than oneifth the diameter. Carcasses are riveted to wooden bottoms when fired from guns and howitzers, but not when they are fired from mortars. They are used to set fire to shipping, buildings, &c. The fuze composition inserted nto each vent is ignited by the flash of the discharge, continues burning during the flight of the projectile, and thoroughly ignites the carcass composition. This composition then burns with great violence out of the three vent ioles, setting fire to everything combustible within its reach.

FUZES FOR SMOOTH-BORED ORDNANCE.

1. What fuzes are used with smooth-bored ordnance?—

1.	Boxer's common time fuze . . .	Wood.
2.	„ shrapnell „ . . .	Wood.
3.	„ mortar „ . . .	Wood.
4.	*Pettman's* land service percussion .	Metal.
5.	„ general service „ .	Metal.
6.	„ sea service „ .	B

7. Boxer's 20-inch time fuze . . . Metal.*
8. „ 7½-inch „ . . . Metal.*
9. „ M. L. 9-seconds . . . . Wood.
10. „ „ 20-seconds . . . . Wood.

N.B.—These are used with M. L. R. ordnance also.

2. Describe the common wooden time fuze.—It i truncated beech wood cone about three inches in leng The thick end or top of the fuze, which is about an inch diameter, is hollowed out about a quarter of an inch, foi ing a cup to receive the priming and match, four h being bored through the sides of the cup to receive quick match. The fuze is bored eccentrically parallel its longer axis from the bottom of the cup nearly to bottom of the fuze. On the side of the fuze on wh the wood is thickest two small powder channels are dri from the bottom nearly to the top of the fuze, about h way between the composition bore and the side of fuze, and parallel to the latter. The composition bor filled with fuze composition, the powder channels with f grain powder. Side holes ·2 of an inch apart are b into the powder channels, those on one side marking even, and those on the other the odd tenths of comp tion. The two bottom side holes are drilled through the composition to ensure the ultimate action of the f in case of imperfect boring at the required tenth in hurry of action. A piece of quick match is threa through each of the bottom side holes to afford supp to the powder in the powder channels on the disch of the gun. The ends of the powder channels are cl with a piece of quick match pressed down, and secu *with shellac* putty. The side holes, with the excep *of the two bottom* ones, are filled with F.G. powder pres *own, and* covered with finely-ground clay.

3. In what does the diaphragm fuze differ fro

* Now nearly obsolete.

common?—It differs, 1st, in containing only one inch of fuze composition; 2nd, the powder channels of the diaphragm fuze are connected by a groove cut on the end of the fuze, and laid with quick match. This secures the simultaneous explosion of both powder channels, and a consequent increase of flash.

4. Describe the mortar fuze for 13-inch, 10-inch, and 8-inch mortars.—The composition bore is situated in the axis of the fuze. There are no powder channels. There is only one row of side holes placed spirally round the fuze, but, with the exception of the bottom one, these do not penetrate into the composition. The latter is not primed with quick match, nor is it closed or protected in any way. It is considerably longer than the common fuze, and contains six inches of fuze composition. There are no match holes in the sides of the cup, the quick match, six inches n length, being doubled down, and the ends coiled inside the cup. In other respects the construction of the fuze is dentical with the common fuze.

5. Is there not a small mortar fuze for 12-pr. and 24-pr. common shells when fired from 5½ and 4⅖ mortars?—Yes, but it in no way differs from the above except in dimensions, the composition bore being the same size as that of the common fuze, and it only contains three instead of ix inches of composition.

6. Describe Pettman's L. S. percussion fuze.—Pettnan's L. S. fuze has a body made of gun metal two inches n length, conical in form, and screwed to fit the fuze holes f common shells. It has a plain projecting shoulder, upon which the fuze rests when screwed home, and on this houlder are four wrench holes equidistant from one nother, by means of which the fuze is screwed into or *ut of the shell.* The body is hollow from end to end, *ing tapped* at top and bottom to receive the top and *ttom plugs.* The interior is plain and cylindrical, with t

exception of a slight rounding inwards immediately the bottom plug. In addition to the body there component parts, viz.—

(1) The top plug.
(2) The bottom plug.
(3) The lead cup.
(4) The cone plug.
(5) The detonating ball.
(6) The steady plug.

(1) The top plug is a cylinder of gun metal s to fit the upper end of the fuze. This plug clo top of the fuze.

(2) The bottom plug is a gun metal cylinder s to fit the bottom of the fuze. On its upper side i small projecting stud, and on its under side a sm by which it is screwed into the body. This pl two holes in it; one vertical through its longe This is the fire-hole, through which the flash fr explosion of the composition in the fuze commu with the bursting charge of the shell. The oth tical contains a strand of quick match to prev powder dust from the charge working into and c the fuze. This quick match also increases the fla the shell.

(3) The lead cup is a hollow cylinder of pur completely open at the bottom but having only hole at the top. This cup rests upon the botto the lower part of it adapting itself to the rounde of the interior of the lower part of the body, an surrounding though not touching the stud of the plug.

(4) The cone plug is made of a rather harde than the body of the fuze. It is called the co from the top end being bevilled, which gives t part of the plug a conical form, otherwise it

cylinder, which exactly fits the interior of the body. From the lower side of the plug projects a stud similar to that upon the bottom plug, and the plug is perforated vertically with a fire hole. It rests upon the lead cup, its stud entering the small hole in the top of the cup.

(5) The detonating ball is a solid sphere of the same metal as the cone plug; it is roughed or milled over its surface, and a groove is cut round its horizontal circumference for the double purpose of allowing a greater quantity of detonating composition to be placed upon the ball, and of giving the composition a better hold. At the bottom and top of the ball are two projections, the lower one conical the upper cylindrical, with a small shoulder round its base. Round the neck of each projection is a groove. The ball is plastered over its whole surface up to but not in the grooves on the projections with detonating composition. The composition is covered with sheep's gut tied on with silk cord and varnished, and afterwards with thin silk similarly secured and varnished. These coverings diminish the sensibility of the ball to the point requisite to prevent premature explosion, and protect the detonating composition from damp. The ball rests with its conical projection in the fire hole of the cone plug, the upper or cylindrical projection entering a hole in the steady plug.

(6) The steady plug, of the same metal as the ball and cone plug, exactly fits the interior of the fuze. A hole is drilled through the vertical axis of the plug, not to serve as a fire hole, bnt for the admission of the upper projection of the ball. The top side of the plug is slightly hollowed out. The steady plug is placed immediately under the top plug and immediately over the ball. The fuze having been put together, the ke hole in the top plug and the cross cut in the bottom p are filled with putty, and discs of paper, varnished

placed over the top and bottom of the fuze, the bei to exclude all moisture. A leather collar is secured shellac varnish to the under part of the shoulder of fuze.

7. Describe the action of this fuze.—It requires no p paration. The shock of the discharge crushes up the l cup. The other moveable parts of the fuze are shiftec a position nearer the bottom of the fuze by as much as cup has flattened, and all reaction is checked by the flattening round the studs of the bottom and cone plı these parts being thus secured to the bottom of the fı The studs on the cone and bottom plugs also serve to p vent the lead cup from flattening over the fire holes. steady plug steadies the ball at the moment of the sh of discharge, and prevents it falling on its side as it otherw would do, and being brought into violent contact with sides of the fuze, which would be certain to cause premat explosion. On the shell striking an object the ball thrown forward, the detonating composition is brou into violent contact with some part of the interior of fuze, is exploded, and the flame passes through the holes in the cone and bottom plugs into the burst charge.

8. In what respect does Pettman's sea-service f differ from the above?—Principally in an arrangement which the sensitiveness of the fuze is so exactly regula that the fuze will not explode on striking water wit high velocity, while it will explode on striking a sh side or other hard substance with a low velocity. It a differs in some minor details of construction.

9. *Describe* Boxer's 20-inch metal fuze.—It resembl *the common fuze* in principle, but differs much from i *construction.* The body of the fuze is made of gun m *t is five inches* in length externally, the lower part *nical; above this,* for about an inch, it is cylindric

screwed with a right-handed thread to fit the (Moorsom) bush of naval shells. Above this is a plain cylindrical projecting shoulder, upon which the fuze rests when screwed home. This has four wrench holes on the top, equidistant from each other, by means of which the fuze is screwed into or out of the shell. From the centre of the group of wrench holes there projects upwards a cylindrical neck nearly half an inch in length, screwed to receive the cap by which the fuze is closed until the moment of ramming home.

The fuze is bored to within ·2 inch of the bottom. The bore is about ½ an inch in diameter, and is tapped with a fine thread to receive a hollow rolled cylinder, of paper smeared with shellac varnish on the exterior, with which the bore is lined. The lower end of this cylinder is closed with a card-board disc.

The bore, lined as described, is pressed or driven with fuze composition, the paper lining preventing the deterioration of both metal and composition from the contact of the two, and also helping to protect the composition from exposure at the side holes. The fuze is matched and primed in the same way as mortar fuzes. The priming match and composition are bored through in the usual way to facilitate ignition. It has two rows of side holes drilled completely through the metal which are pressed with ground clay, with exception of the bottom hole —that is, the lowest hole on the even row. The top hole of one row is situated 1·5 inches below the zero point, and the top hole of the other 1·6 inches, and as both these holes are within the shell when fused, powder channels are unnecessary. The fuze has a gun metal cylindrical cap with the sides slightly squared to give a hold to the key. A leaden marker is placed over the nu and on to this the cap is screwed home tightly; a leat collar is secured by shellac varnish to the under pa

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the shoulder of the fuze with a view to excluding m
more completely from a fused shell. The times of b
or times of flight, which are synonymous in secon
half seconds, are stamped against the alternate sid
This is a great improvement on the method adop
common and mortar fuzes, as it does away with the
calculation required with the latter.

The preparation of the fuze for any time of flig
tween 7½ and 20 seconds consists in boring throu
clay and paper lining at one of the side holes, but
fuze be required for a shorter time of flight t
seconds, the first 1·4 inches of composition must be
through with a brace and bit provided for the p
The top hole thus becomes, by the lowering of tl
point to within ·1 of an inch of it, ½ a second ins
7½ seconds, and each of the remaining side hole
7 seconds less than it is marked.

The action of the fuze is the same as that of the
fuze.

10. Describe Boxer's 7½-seconds metal fuze.—In
appearance it resembles the 20-seconds fuze. It is a
same in construction and dimensions, but is adap
shorter times of flight and capable of adjustment for
instead of half seconds. This fuze is pressed with
powder instead of fuze composition, and its rate of b
thereby increased to ·2 inches in 5 seconds, the norn
of burning of pressed mealed powder. The redu
time in burning of a 20-seconds fuze of one-half wou
10 seconds, but as this is in excess of the full time re
an inch of composition is removed, leaving 3 inches
meal powder, thus giving a total time of burning
seconds. The side holes, placed ·2 inches apart, a
number on the even side and 14 on the odd. This
be gradually superseded by the 9-seconds Bo
time-fuze.

11. Describe Boxer's wood M.L. 9-seconds fuze, for naval .B. shells and M.L.R. guns.—It resembles the common ıze in its main features of construction, but differs from it ı several points of detail, which are—

(1) In the head.
(2) In the body.
(3) In general dimensions.

In the head the principal difference consists in the in- oduction of a gun-metal plug, which is screwed perma- ɜntly into the upper part of the composition bore flush ith the top of the fuze. The object of this plug is to ose the top of the fuze completely, and so to prevent (1) ıe extinction of the fuze, striking on end, and (2) the great ɔceleration of the rate of burning of the composition, hich is induced by the pressure of the air on an unpro- cted fuze fixed in the apex of a rifled shell. The plug ɔcessitates a different method of priming. From the ntre of the plug projects downwards a copper pin, round hich is looped a piece of quick-match, the ends of this atch being passed through two escape holes, which are ovided in the side of the head for the escape of the flame om the composition. The quick-match is laid in a groove ound the head of the fuze, and is covered by a strip of iin sheet copper, the copper being covered by a tape band, ıe end of the copper band being exposed.

The body of the fuze differs from the common fuze prin- pally in being lined with paper. This lining serves two ırposes:—1st, if the wood shrinks, it prevents the forma- on of a space between the wood and composition, which ould cause the fuze to explode (on the principle of a tube), ıstead of burning regularly; and 2nd, it enables the side ɔles to be *made* deeper, thus diminishing the thickness of ɔod *to be bored* through in preparing the fuze. The side les *are plugged* with rifled powder, only the ground cl ıg *dispensed* with. The bottoms of the powder ch

nels are not, as in the common fuze, closed with sh putty, but are connected at the bottom with a piec quick match, as in the diaphragm fuze. Above the of the top side hole the composition bore is driven mealed powder, instead of fuze composition, to ir greater accuracy when the fuze is prepared for s ranges.

In dimensions this fuze differs from the common in b about one inch longer, to give room for the plug, ar being cut from a somewhat thicker part of the same to adapt it to the general service fuze hole.

It is prepared for use in the same manner as com fuzes, with the exception that it is uncapped by strip the tape and copper band from the priming by mea the exposed end of the copper which is left to lay hol N.B. *This should not be done until the shell is in the bo the gun.*

The fuze composition burns out of the two escape provided for the purpose.

This fuze can be used with all muzzle-loading whose shells have the general service fuze-hole or ada whether M.L.R. or smooth bore, and has been adopte the Navy for spherical shell and will supersede th seconds fuze.

It can be used also as a percussion fuze when firing rifled guns only, even with low charges, against earthw or ships, without further preparation, the fuze being dr on impact into the shell, and the shell thus exploded mallet is not necessary to fix this fuze; it is only nece to press the fuze with the hand, screwing it at the time into the bush or adapter as far as it will go. reduced charges, the quick-match should be made to ject from the groove, and where very reduced charg used two or three strands of quick-match in addition be tied round the projecting part of the fuze.

12. Describe Boxer's 20-second fuze for M.L. Ordnance. —It resembles in part the 9-seconds fuzeand in part a mortar fuze. It has the metal plug, the escape holes, priming, copper, and tape bands round the head, and the paper lining of the former, but it has only one row of side holes, disposed spirally, and has no powder channels—in this respect resembling the mortar fuze. It differs also in having 4 inches of composition, and a hole is bored transversely through the fuze, immediately below the composition, for the reception of a pellet of mealed powder pierced like a tube. The ends of the hole are protected by discs of thin paper secured with shellac varnish. The side holes are numbered as in the large mortar fuze, from two inches downwards, but each hole is numbered in tenths of an inch. It is uncapped, like the 9-seconds fuze, and bored like a mortar fuze. It can be used with all shells, smooth or rifle M.L., under the same conditions as the 9-seconds fuze. It will supersede the 20-seconds fuze for naval spherical shell.

AMMUNITION FOR RIFLED ORDNANCE.

1. What projectiles are used for rifled ordnance?—Solid shot, case shot, common shell and segment shell, Shrapnel and Palliser shot and shell. They are all of an elongated form. The fuze hole of the common shell is bouched with gun metal.

2. *How are projectiles for rifled ordnance made to t the rifling?*—For breech-loading ordnance they are c

with lead. For muzzle-loading ordnance soft st attached corresponding to the grooves in the gun.

3. What are the charges of powder for B. L guns?—One eighth the weight of the shot.

4. If the cartridge does not fill the chamber, done?—A paper cylinder is placed in the cartrid into this the lubricator is screwed.

5. What is the lubricator?—Two copper cups s together containing tallow and oil.

6. How is the lead coating of all breech-loading tiles now attached?—By zinc solder. The zinc mates sufficiently with the iron and lead to give complete attachment.

7. Describe the segment shell B. L.—Segmen consists of a thin cast-iron, cylindro-conoidal shel 2½ calibres long, lined with cast-iron segments bui layers, having a cylindrical powder chamber in the The base is closed with a cast-iron disc. A thin an alloy of lead 19 parts, and antimony 1 part, from base to shoulder. The alloy also flows in l the segments and lines the powder chamber, givin weight and solidity. The lead coating is ·05 in over body and ·1 inch over base, a canneline round the shell to take any lead stripping off tl part. The increased diameter at base is intended vent windage, and enable the projectile to be simultaneously at shoulder and base on rammin and also to retain the grip until the base leaves the Every segment shell has four longitudinal groove interior of the head. Uncoated portions of she and bottom) are painted black, extending over the prevent corrosion, &c.

8. How many classes of B. L. segment shell —Two. Garrison and field. The garrison 7-in 40-pr.; the field are 20, 12, 9, 6-pr. The f

garrison segment shell has a gun-metal bush ·9 below the apex of the shell of Moorsom gauge, with an adapter permanently fixed in the shells, and take Boxer's 9 or 20-sec. B. L. R. O. time, or Pettman's G. S. percussion fuze. The fuze hole of every field service segment shell is cylindrical, topped with a coarse left-handed thread, closed by a gun-metal screw plug with loop.

9. Describe the common shell B. L.—This is simply a cast-iron shell, lead-coated like the segment, and of the same general form, but differing in dimensions mainly in being about half a calibre longer ; the head also is rather more pointed. The regulation for form of head now laid down is to employ a radius of 1·5 diameters for all shell heads. It is often very difficult to distinguish common from segment shells ; the leading feature is the difference in length. There are six sizes, viz. 7-inch 64, 40, 20, 12, and 9-pr. All common shell are lacquered internally, and have no grooves.

10. Describe the shrapnel B. L. (Boxer's).—Each shell consists of a hollow body, with a head attached to it lightly. The body is of cast iron, with the usual lead and antimony coating. The body is weakened internally by six longitudinal grooves running down the entire length of the interior, and forming lines of least resistance. The base is formed into a chamber to contain the bursting charge. The interior of the body is slightly conical, that is, it enlarges towards the front, giving an increase of ·1 inch in diameter in larger, and ·05 inch in smaller calibres at the mouth. Running round the mouth is a shoulder and groove, forming a kind of recessed lip. Over the mouth of the powder chamber rests a disc of iron or diaphragm, supported either by flanges or by a shoulder according to pattern. The diaphragm is pierced in the centre, a partly tapped to take a wrought-iron tube, which is scre into it, this tube itself being tapped at the top to t

gun-metal primer employed to assist in carrying the flash of the fuze to the bursting charge in the chamber. On the diaphragm are placed bullets of lead and antimony, which are fixed by resin being run in among them, brown paper being laid round the inside of the shell to prevent too firm adhesion of the resin. Over the bullets and resin is placed a kamptulicon disc. The head is made of elm, covered with a light shell of Bessemer metal, the wood being bored out to contain a tin socket fitting round the iron tube of the body, and holding in its mouth a gun-metal bush of general service gauge, tapped to take the general service screw plug. This bush forms a small projecting socket above the apex of the shell. This head is attached by means of steel rivets (twelve in larger and four in smaller shells), and four steel twisting pins, these latter being rivets fitted into slots instead of holes in the shell, so as to tend to prevent the head by its own inertia twisting away from the body, although in no way interfering with its liberation when blown to the front by the bursting charge. The 64-pr. has its tube surrounded by a hollow elm-wood cylinder, to enable its proportions to be good consistently with the calibre and weight required. All shrapnel have weighed bursting charges of "service pistol powder." The 7-inch 64 and 40-pr. shells take the 9-secs., the 12 and 9-pr. the 5-secs. B. L. R. O. fuze. Boxer's shrapnel have superseded segment to a great extent for large calibres, and are recommended to come in for smaller calibres in a certain proportion.

11. How many calibres are there of solid shot?—Five, viz. 40, 20, 12, 9, and 6-pr.

12. Describe B. L. solid shot.—In their general appearance externally solid shot much resemble segment shell, but they differ in length, in the 40-pr. the solid shot being ither shorter, and in other calibres rather longer than the ment shell. The weight of the shot generally exceeds

at of the segment shell of the same calibr
both projectiles are attached by the same n
13. Describe the present service patterns
L.—For large calibres 7-inch 64-pr. and
se is sheet iron with fringed ends. An iro
reted to the lower fringe, on which rests a w
sc ; on this stands a lining of three wrought i
ates or segments ; within are sand shot (8-oz.
al dust, and covered with an iron top fringed an
wn. The 7-inch and 64-pr. have an iron hand
The smaller calibres 20, 12, 9, and 6-prs. ha
ned iron case with tin bottom and an iron
side, and an iron bottom riveted to the outsid
od top zone shaped (to facilitate loading) cove
. The 20-pr. has 4-oz. balls, the 12 and 9-
lls and the 6-pr. 1-oz. balls, all of iron. Th
bres (7-inch 64 and 40-prs.) have solder stu
ller calibres solder rings divided in four pl
, to prevent them being pushed too far up tl
e gun.
4. When is case shot most effective?—The e
shot depends chiefly on its ricochet, and what
range is commonly the limit of its ricochet
ound ; over boggy ground it is nearly usele
is the extreme range at which it should
the most favourable circumstances.

ARMSTRONG SHUNT PROJECTILES.

1. What are the only 64-pr. M. L. shells now in service ?—

1st. Common.
2nd. Shrapnel (Boxer).

The common shell differs from the 64-pr. B. L. s first, in not being lead coated, and in having three s rows of copper studs (pitch 1 in 40 calibres), three s in each row, riveted into undercut holes. Secondly calibre of the shunt gun is 6·3 inches instead of 6·4 in the diameter of the M. L. shell being 6·22 inches, and of the body of the B. L. shell 6·43 inches. Thirdly, t small extractor holes, one made in the head, one in pro gation of each row of studs. It has an unloading ·75 inches in diameter, with a metal screw plug and pa mache wad beneath. The fuze hole, as with the B. L. s is bushed to the general service gauge. New shells now made with the G. S. fuze hole.

The principle of construction of the shrapnel is i tical with that of B. L. shell, but differs in the follo particulars :—1st. In not being lead coated, but stu like the common shell. 2nd. In dimensions, as in common shell, and in being half an inch longer than for the B. L. gun, and the dimensions of all its parts affected proportionally. 3rd. It has extractor holes the common shell. 4th. It contains 234 lead and a mony bullets, instead of 224. It has the same socket general service bush as the B. L. shell; it is readily di guished from the common shell by its projecting so and also by the shoulder or lip at junction of head body.

2. What description of shot is used for the muzzle loader ?—Case shot is the only shot now

the service. This shot differs from the 64-pr. B. L. case in the following particulars :—1st. On account of the difference in the bores of the guns it differs in calibre; in other dimensions also it differs, being ·6 inch longer than the B. L. 2nd. It has no solder studs at the base. 3rd. It contains 56 sand shot (8-oz.) instead of 58.

PROJECTILES FOR WOOLWICH GUNS.

1. What are the projectiles now in the service for Woolwich Guns ?

Shell, common, double, shrapnel, and Palliser's.
Shot, Palliser's and case.

2. Describe the common shell.—The general form is about 3 calibres in length, with ogival head $1\frac{1}{2}$ diameter radius; the 12-inch and 13-inch, however, are shorter than the above, the 13-inch being only 29·5 inches, and the 12-inch only 30 inches long. All are lacquered internally with red lacquer. They have two extractor holes in their heads; the fuze hole gauge in all is the G. S., countersunk ·2 inches and bushed; they have also unloading holes.

3. Describe the double shell.—The 7-inch double shell is the same as the common shell prolonged to a length of 27·2 inches, and strengthened by three internal flanges running longitudinally, to give the necessary support to prevent the shell breaking up in the bore of the gun.

This shell is intended to be fired at wooden ships at short ranges.

4. Describe the shrapnel shells.—They resemble the 7-*inch breech-loader* shell in their general features, but *ave gun metal* studs instead of lead coating; have two ex- *tractor holes*, vary slightly in their proportions, ar

with exception of the 7-inch Mark I, they contain san shot instead of mixed metal balls. They have the G. gauge bush.

5. What are Palliser projectiles?—Projectiles of iro cast in a metal chill to render them hard for the penetra tion of armour, providing for the evil effects of brittlenes by the form of head. In those last manufactured, th heads are cast in metal and the bodies in sand; they wer first proposed by Major Palliser in 1863.

6. Describe the Palliser shell.—The form in all calibres cylindro-conoidal, the head being ogival struck with a radiu of 1½ diameters; the total length varies between a litt over 2 calibres and a little over 2½ calibres; the botto is flat, but rounded at the edge to facilitate loading. In th centre of the bottom is a filling hole bushed with wrough iron, and closed with a gun metal screw plug which should tightly and evenly, and is, therefore, selected for each she and not intended to be interchanged with that of anothe The wrought iron bush is cast into the shell, being plac for this purpose on the spindle of the core; it has groov running round its exterior to cause the metal to enter an hold well in round it, and for more secure closing of th joint, the top flange is removed in the form of an annul groove in the shell's base, undercut towards the fillin hole, and of such a width as to bring the junction wrought and cast iron along the middle of the groove in which is hammered a ring of lead. To distinguish the they are now all painted black with a white tip, the stu are unpainted as with other projectiles. To prevent pr mature explosion of these shells, serge bags, bottle-shape are introduced through the filling hole. All Palliser she are completely filled with L. G. shell powder.

7. Describe Palliser shot.—They are, with one ex tion, a 7-inch original pattern, cored. This hollow ce centre renders the shot less liable to split in store

[redacted]

molecular action; it also slightly improves its proportions and shooting powers. These projectiles externally closely resemble Palliser shell. The 12-inch and 10-inch are made with ogival heads of 1½ diameter radius, and the 9-inch, 8-inch, and 7-inch cored shot with ogival heads of 1¼ diameters radius. All have a hollow running up the axis of the body and entering the base of the head, this hollow being formed in casting like that of a shell by a core; hence the name "cored shot." The 7-inch solid shot has an ogival head struck with a radius of one diameter only. The base is bushed with a wrought iron bush, cast in and sealed with lead like that of Palliser shell. It has a wrought-iron screw-plug, which is made with a square head, nicked to enable it to be twisted off and filed flush after screwing home. These shot are painted black all over except the studs.

8. Describe the case shot.—The general principles are the same as those for B.L. case. They are of the Royal Laboratory pattern, that is, with segmental linings and coal dust, 8-oz. sand shot being used, and the weight for 7-inch three-fourths the weight of projectile, and for larger calibres the weight of a round shot of the same calibre. The diameter is slightly less than that of other projectiles of the same calibre in all except the 12-inch. The high limit of the former is the mean of the latter.

PROJECTILES FOR 7-POUNDER MOUNTAIN TRAIN GUN.

1. *What projectiles are used with these guns?*

1. *Common* shell.
2. *Double* shell.
3. Shrapnell shell.
4. Case shot.

The common shell is rather over two calibres in head ogival with radius 7·5 inch; fuze-holes are unbı the diameter of shell 2·94 inches.

Double shell was introduced for firing at high angle a reduced charge, and enables the gun to be use howitzer or mortar. The shell differs from the co only in certain dimensions.

Shrapnell shell is rather over two calibres in l the shells are constructed on the same principle as for larger guns. The studs are of zinc for all the swedged in undercut holes, two studs for each gro the gun of which there are three.

Case shot for the 7-pr. is now made with an enve tin, the two bottoms and lining being of sheet iro diameter 2·94 inches. It contains 82 mixed met (1 oz.).

FUZES FOR RIFLED ORDNANCE.

1. What fuzes are used with B.L. segment she fuze-hole of every F.S. segment shell is cylind takes the E or F time-fuze with E percussion an The C. percussion fuze may be dispensed with b the serge-covered wooden plug carried over the the shell beneath the same, so as to bring it cl time-fuze; but this should not be done unless necessary.

2. What fuzes are used with common shell *12-pr. and 9-pr.* C percussion and E. or F. time

3. What fuzes do the garrison service B.L. —*The Boxer 9-secs. or* 20-secs. B.L.R.O. time *G.S. percussion fuze.*

4. What fuzes are used with B.L. shrapn

64-pr. and 40-pr. shells take the 9-secs., the 12-pr. and 9-pr. the 5-secs. B.L.R.O. fuze.

5. What are the fuzes for Armstrong shunt shells?—The 64-pr. common shell is now bushed to the G.S. gauge, and take Boxer's 9 or 20-secs. M.L.O. or Pettman's G.S. fuze. —The Shrapnel takes the 9-secs. M.L.O. fuze as its service fuze.

6. What fuzes do the common shell for Woolwich guns take as service fuzes?—Boxer's 9 or 20-secs. M.L.O. or Pettman's G.S. Double shell take the 9-secs. or Pettman's G.S.

7. What fuze is used with shrapnel?—The 9-secs. Boxer M.L.O. fuze as its service fuze.

N.B. The 9 and 20 secs. fuzes Boxer M.L.O. and Pettman's G.S. fuze have been already described. It would lengthen out this small work too much to describe all the B.L. fuzes, some of which are already obsolete, and others likely to become so before this little work is published. It has, therefore, only been thought necessary to mention the fuzes used with each description of shell.

8. Are there not special fuzes for the mountain train guns?—Yes, there are three—the 5, 10, and 15-seconds Boxer special M.L.R.O. fuzes.

9. What are the chief points to be remembered in considering whether a given fuze will suit any shell?

(1) Gauge of fuze, whether common, Moorsom, general service, or field service.

(2) Whether there is windage. As to ignition of time-fuzes by flash of discharge.

(3) Enlarged interior. With field service common shell will require a screw pattern fuze.

(4) Whether the fuze has powder channels, so as to *take the flash* out at the bottom as well as the sides; th *action* being necessary in all shrapnel shells, and also for exa *certain* lengths of burning in some others,

l not suit shrapnel shell, even if
et.
any time for another, care must be
le hole does not appear above the
ole, as the flash might enter thus:
might be fired from a 24-pr. shell
ar, but the 9-secs. might not.
ıgth of fuze burns sufficiently long for
d.

GUNPOWDER.

the ingredients and proportions of gun-
the British service?—Nitre, 75; charcoal,
) in 100 parts.
pearance should it present?—Uniformity of
should be angular, crisp, and sharp to the
asily reduced to dust by the fingers, or dusty
Its specific gravity should be not less than
he cubic foot. Half an ounce flashed on a glass
d leave little or no residue.
may damaged powder be treated?—It may be
or, if damp, it may be restored and dusted; bu
ıld only be used for bursting shells or for blar
ıtion.

NS OF IGNITING THE CHARGES OF G

How are the charges of guns ignited?—By me
, portfires, or slow match.
What tubes are now used in the service?—T
copper friction tube for land service and
or sea service.

3. Describe the copper friction tube.—This tube is made entirely of copper. The barrel, like that of all other tubes, is ·2 inch in diameter. A short piece of tubing called a nib-piece is fixed by solder and wire near one end of the barrel and at right angles to it, a hole of communication being bored through the barrel into the tubing. A small piece of copper called the friction bar, having its surface roughened, is placed in the centre of the small tubing, the outer end being formed into a ring to which the lanyard is hooked. A small patch of detonating powder is placed above and below the nib-piece, and the tubing compressed on to it by means of pincers. The strip, on being pulled smartly from the tubing, causes sufficient friction to ignite the detonating composition, which communicates with the composition (meal, powder, and spirits of wine) in the barrel. The top of the tube is sealed with putty and the bottom closed with shellac paper.

4. Describe the quill friction tube.—The quill tube is made on the same principle as the copper, only quill is used instead of copper, the latter being objectionable on board ship. In this tube the friction bar passes through a slit cut in the top of the barrel, and there is only one pat of detonating composition, which is placed above the bar. The bar is covered with ground glass and shellac, and its end is turned down to ensure ignition; over the pat is placed a little rifle powder, and above this a mixture of ground clay and beeswax, the whole being closed with a parchment cap. The head of the tube is woulded with copper wire to strengthen it, and a leather band is tied on, its end passing round the exposed part of the friction bar. The tube is fired with a metal crutch attached near the vent; this crutch supports the head and prevents it *bending* when the friction bar is pulled, and the lanya *passes through* a guide plate fixed to the breech so th *may be* pulled in the required direction.

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Both tubes are fired by means of a lanyard, which is a stout cord having a metal hook at one end to fit into the ring of the friction bar.

5. What is a portfire?—There are two kinds, the common and slow portfires. The common is a paper case about sixteen inches long, into which is driven a composition which burns at the rate of rather more than one inch a minute. The composition for portfires is—

	lbs.	oz.
Saltpetre, ground - - -	6	0
Sulphur, sublimed - - -	2	0
Powder, mealed - - -	1	4

6. What does slow portfire consist of?—Paper steeped in a solution of saltpetre and rolled into a solid cylinder.

Solution :—

Saltpetre, 12 oz.
Water, 1 gallon.

7. How many different kinds of match are there?—Two, namely, cotton quick match and slow match. The first is merely cotton coated with a composition of mealed powder, gum, and water, and is used for many purposes, such as firing trains, priming of fuzes, &c. Slow match consists merely of hempen rope boiled in a solution of wood ashes and water; it burns at the rate of a yard an hour, and is very useful in firing charges of powder when some time is required between the placing of the match and ignition of the powder. Quick match, when inclosed in paper tubing, explodes almost instantaneously, and is useful in this form in connecting charges of powder, rockets, &c., that require to be fired simultaneously.

MISCELLANEOUS QUESTIONS.

1. What is the calibre of a gun?—The diameter of the bore.

2. What is windage?—The difference between the diameter of the bore of a gun and the diameter of its shot.

3. What is the windage allowed in field guns (smooth bore)?—·1 of an inch.

4. Why is windage necessary in smooth bore guns?—1st. The impossibility of casting shot perfectly spherical. 2nd. To allow of increase of diameter of shot from rust or expansion when heated. 3rd. From the fouling of the bore of the gun.

5. What are the disadvantages of windage?—1st. Loss of force from the escape of gas round the shot. 2nd. Irregularity in flight of the projectile. 3rd. Injury to the bore of the gun from the rebounding of the shot in the bore. This is partially obviated by attaching wooden bottoms to the projectiles.

6. What is the preponderance of a gun?—The excess of weight in rear of the trunnion.

7. When laying a gun, should one trunnion be higher than the other, to which side is the shot thrown?—To the side of the lowest trunnion.

8. When is a gun laid point blank?—When its axis, prolonged, would pass through the point aimed at.

9. Define the following terms:—Trajectory, line of fire, line of sight, angle of elevation, deflection, initial velocity, and derivation.—"Trajectory:"—The curved line described by the projectile in passing from the gun to the object. "Line of Fire:"—The axis of the piece produced. "Line of Sight:"—The line passing through the two sights and the object. "Angle of Elevation:"—The angle made [by] the line of sight with the line of fire. "Deflection:"—

;UESTIONS.

ɜ of the first graze or impact
ect. "Initial Velocity?"—
rojectile leaves the bore of
ɜ deviation to the right or
red from rifled guns. This
n service projectiles, to be
ıe shot rotates.
lf the difference between the
ıe gun on which the sights are

, sight?—The front sight of ɛ
dispart of that part of the piece
the different positions in whic
ıdvantages and disadvantages
rate the same by rough sketche
ıw (vide Fig. 1) excludes all vi
ıents of the enemy, and is a s

ıch below the enemy. The en
ɜvery part of the battery, whil
irely hidden from sight; even
isible, the velocity of projecti
ıts is to some extent reduced, a
ojectiles as shrapnel depends
ıocity with which the fragment

he highest eminence at hand.
osition that could be chosen.
ı flat trajectory are lost. Sc
ussion fuzes, and shell with t
too long, will stick fast in t
ost harmless, especially if t
If the enemy are placed on h
lind shell will break up on
ch heights as to render

useless. If the inclination of the height on which the guns are posted greatly exceeds the extreme depression that can be given to guns (*vide* Fig. 3) the enemy can form in perfect security at the base of the height for an attack upon the guns. A battery thus placed may happen to form a target for a number of the enemy's guns, and the ineffective fire of guns thus posted will raise the courage of the enemy, while depressing the spirits of our own men. There is also a great waste of most valuable ammunition.

(4) Guns placed on a hillock, gradually sloping to the front and more abruptly to the rear, with a command over the ground occupied by the enemy of about 1 in 100, are in the most favourable position possible.

(5) If the ground does not gently rise in front of the guns, then it is by all means desirable to throw up a small entrenchment or form a gun-pit to supply the necessary cover (fig. 5).

(6) If the top of the hillock is flat and its command sufficient, an epaulement is not required.

(7) If the top of the hillock be rounded off sharply, a small level platform must be dug out on the rear slope, otherwise it might be impossible to depress the gun sufficiently, and the force of the recoil would drive the gun down the back slope of the hill.

(8) If a canal or sunken road, or a railway cutting, be at hand, parallel to the front of the battery, the guns should be run up close to the edge, because all shot or shell falling slightly short are caught by the slope in front and prevented ricocheting.

(9) A low bank or hedgerow, or a furze-bush, may be made use of in the same way as the epaulement in fig. 5. and even a slight irregularity of ground, as in fig. 9, may prove highly useful.

(10) As regards ground plan, guns may be draw

with good effect behind a marsh or pond, ri
provided always that such obstacles do not i
vance to the front impossible, and that in tl
ravine it is not occupied by the enemy. H
ground, as well as stony ground, should be :
is difficult to move guns in the former, a
horses may be wounded by fragments of
latter. In fine, the ground for 50 or 100 y:
of the battery should be as unfavourable a
the enemy's artillery fire, and the ground
and flank should be of such a nature as to
de main impossible.

13. In opening fire at an uncertain range, i
fire short or over the object?—Short.

14. How should the quickness of firing be
Accuracy in laying should be the first conside
hurry should be avoided, but fire once opene
kept up as quickly as, combined with steadi
sible.

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